

Methods of analysis -II

MESH ANALYSIS

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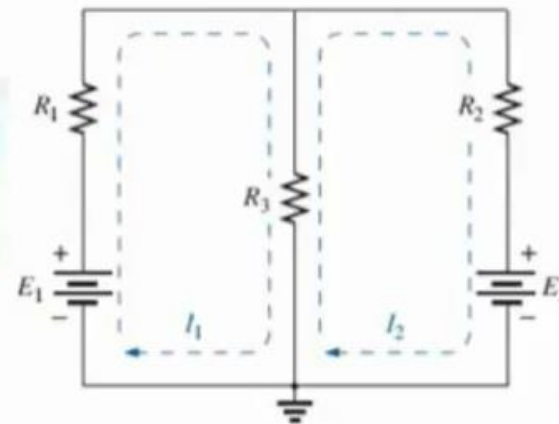
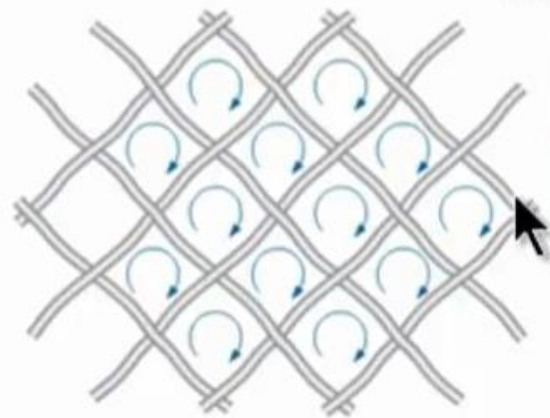
MESH ANALYSIS

- The next method to be described—**mesh analysis**—is actually an extension of the branch-current analysis approach just introduced.
- By defining a unique array of currents to the network, the information provided by the application of Kirchhoff's current law is already included when we apply Kirchhoff's voltage law. In other words, there is no need to apply step 4 of the branch-current method.
- The currents to be defined are called **mesh** or **loop currents**.

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MESH ANALYSIS

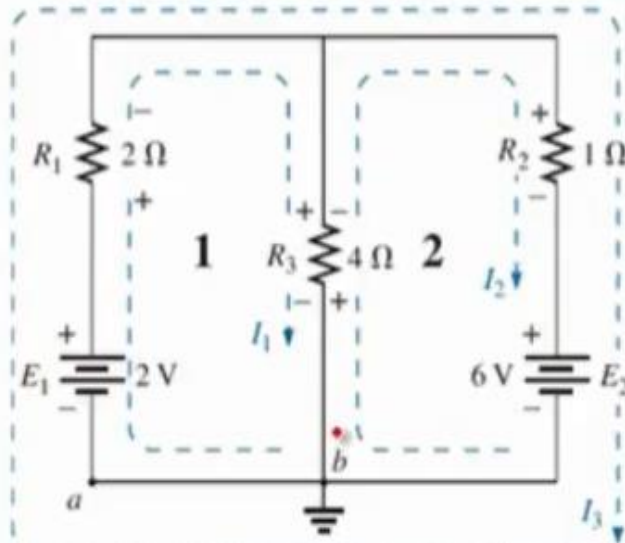
the number of mesh currents required to analyze a network will equal the number of “windows” of the configuration.



Procedure

Mesh Analysis Procedure

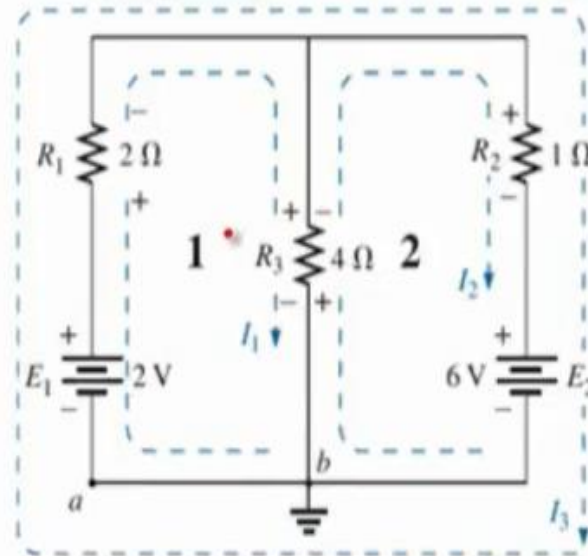
1. Assign a distinct current in the clockwise direction to each independent, closed loop of the network. It is not absolutely necessary to choose the clockwise direction for each loop current.
2. Indicate the polarities within each loop for each resistor as determined by the assumed direction of loop current for that loop.



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Mesh Analysis Procedure

3. Apply Kirchhoff's voltage law around each closed loop in the clockwise direction.
4. Solve the resulting simultaneous linear equations for the assumed loop currents.

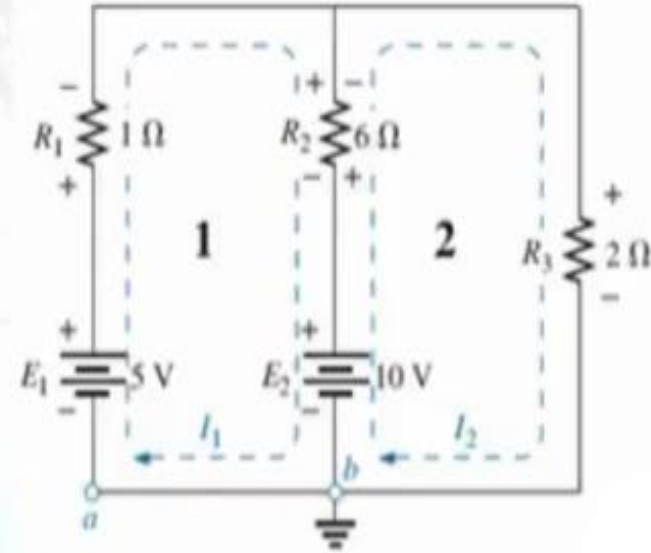


Example

EXAMPLE

Find the current through each branch of the network in Fig using mesh analysis.

Solution:



Steps 1 and 2: These are as indicated in the circuit. Note that the polarities of the $6\ \Omega$ resistor are different for each loop current.

Step 3: Kirchhoff's voltage law is applied around each closed loop in the clockwise direction.

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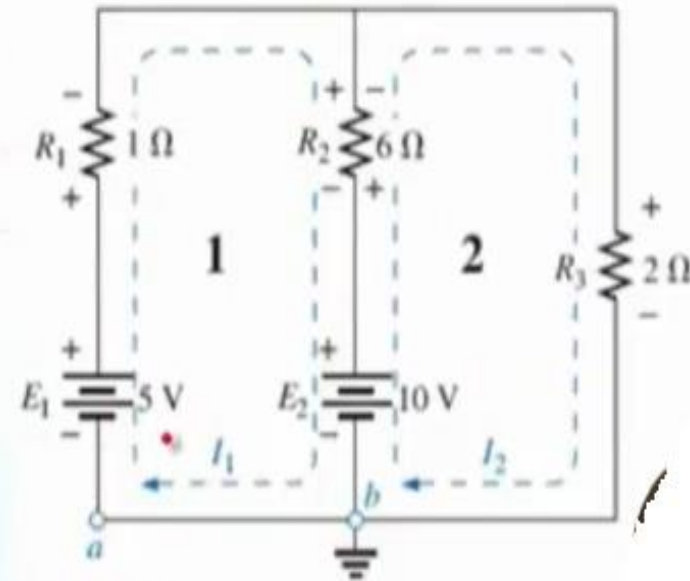
By K.V.L

$$\text{loop 1: } +E_1 - V_1 - V_2 - E_2 = 0$$

$$+5 \text{ V} - (1 \, \Omega)I_1 - (6 \, \Omega)(I_1 - I_2) - 10 \text{ V} = 0$$

$$\text{loop 2: } E_2 - V_2 - V_3 = 0$$

$$+10 \text{ V} - (6 \, \Omega)(I_2 - I_1) - (2 \, \Omega)I_2 = 0$$



The equations are rewritten as

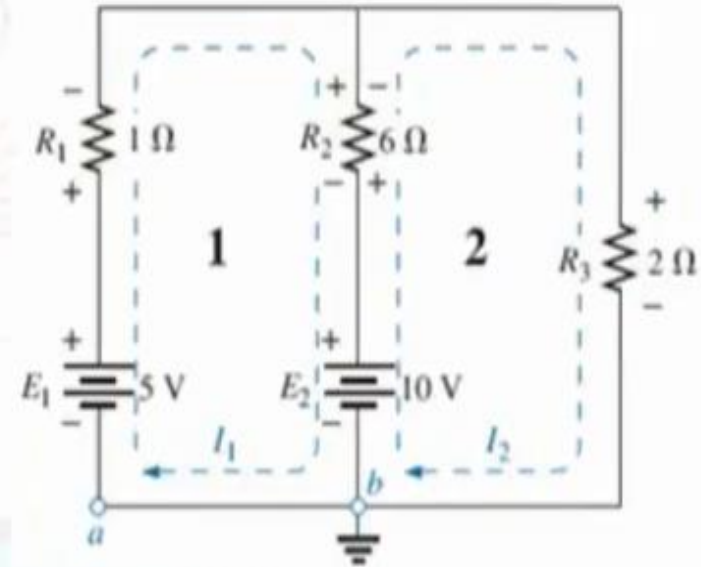
$$\left. \begin{array}{l} 5 - I_1 - 6I_1 + 6I_2 - 10 = 0 \\ 10 - 6I_2 + 6I_1 - 2I_2 = 0 \end{array} \right\} \begin{array}{l} -7I_1 + 6I_2 = 5 \\ +6I_1 - 8I_2 = -10 \end{array}$$

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$$I_1 = \frac{\begin{vmatrix} 5 & 6 \\ -10 & -8 \\ -7 & 6 \\ 6 & -8 \end{vmatrix}}{\begin{vmatrix} -7 & 6 \\ 6 & -8 \end{vmatrix}} = \frac{-40 + 60}{56 - 36} = \frac{20}{20} = \mathbf{1\text{ A}}$$

$$I_2 = \frac{\begin{vmatrix} -7 & 5 \\ 6 & -10 \end{vmatrix}}{20} = \frac{70 - 30}{20} = \frac{40}{20} = \mathbf{2\text{ A}}$$

$$I_{R_2} = I_2 - I_1 = 2\text{ A} - 1\text{ A} = \mathbf{1\text{ A}} \quad \text{in the direction of } I_2$$

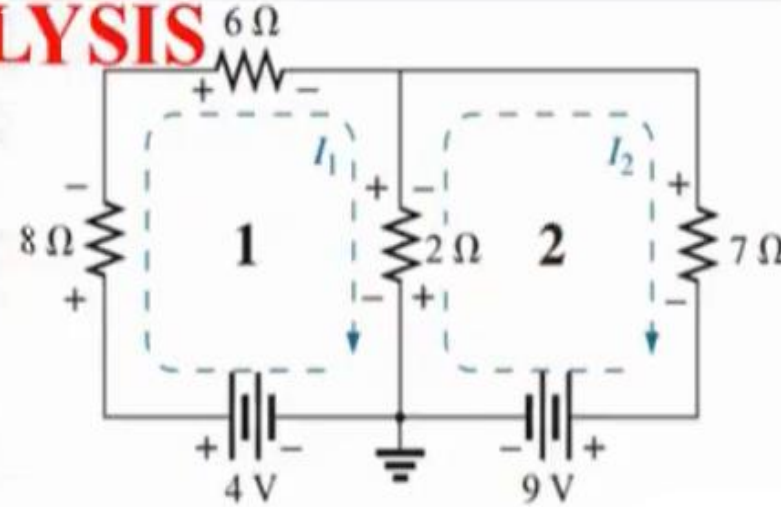


Example

MESH ANALYSIS

EXAMPLE

Write the mesh equations for the network in Fig. and find the current through the 7 resistor.



Solution:

$$I_1: (8 \Omega + 6 \Omega + 2 \Omega)I_1 - (2 \Omega)I_2 = 4 \text{ V}$$

$$I_2: (7 \Omega + 2 \Omega)I_2 - (2 \Omega)I_1 = -9 \text{ V}$$

$$16I_1 - 2I_2 = 4$$

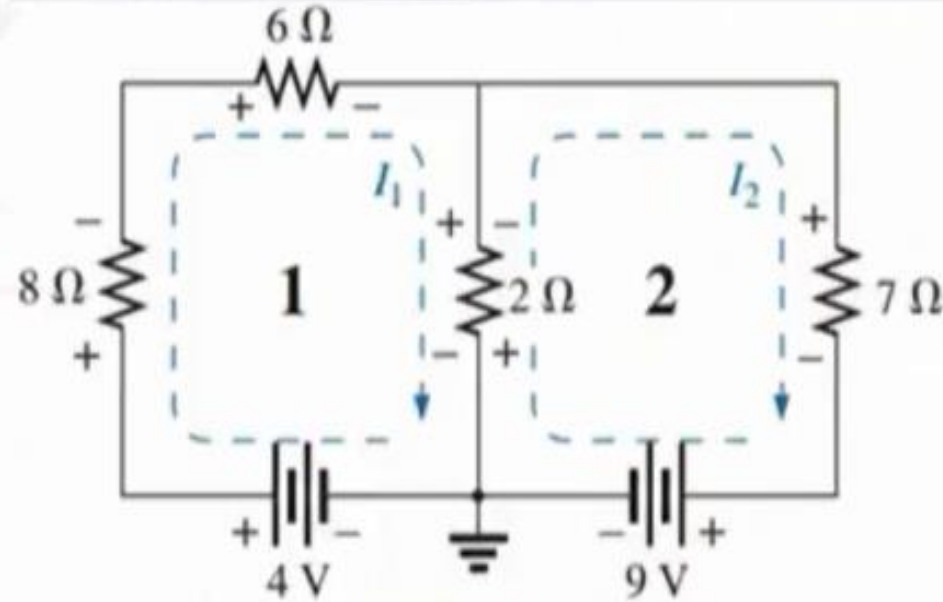
$$9I_2 - 2I_1 = -9$$

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which, for determinants, are

$$\begin{aligned} 16I_1 - 2I_2 &= 4 \\ -2I_1 + 9I_2 &= -9 \end{aligned}$$

$$\begin{aligned} I_2 = I_{7\Omega} &= \frac{\begin{vmatrix} 16 & 4 \\ -2 & -9 \end{vmatrix}}{\begin{vmatrix} 16 & -2 \\ -2 & 9 \end{vmatrix}} = \frac{-144 + 8}{144 - 4} = \frac{-136}{140} \\ &= \mathbf{-0.97 \text{ A}} \end{aligned}$$



Example

EXAMPLE

Find the current through the 10 resistor of the network in Fig.

Solution:

Summing terms yields :

$$11I_1 - 8I_3 - 3I_2 = 15 \text{ V}$$

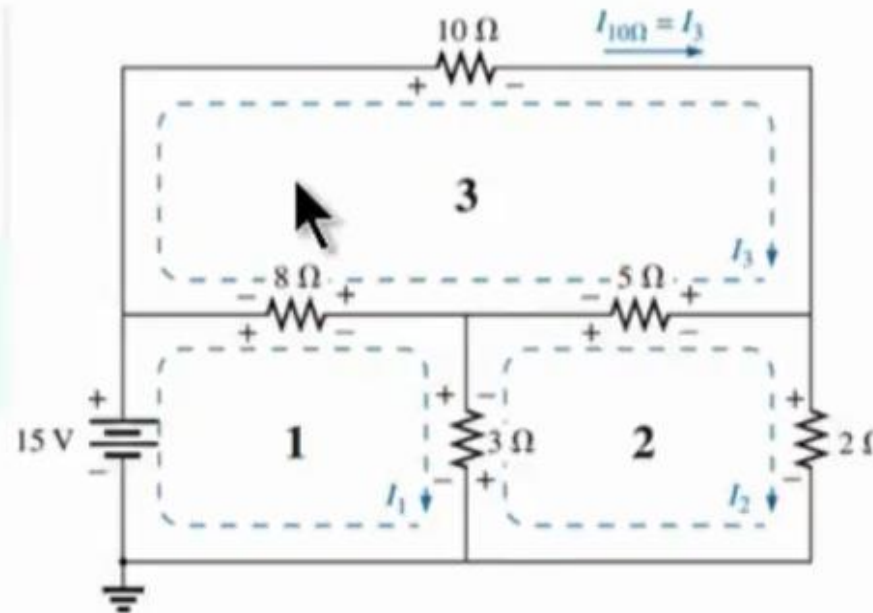
$$10I_2 - 3I_1 - 5I_3 = 0$$

$$23I_3 - 8I_1 - 5I_2 = 0$$

$$11I_1 - 3I_2 - 8I_3 = 15 \text{ V}$$

$$-3I_1 + 10I_2 - 5I_3 = 0$$

$$-8I_1 - 5I_2 + 23I_3 = 0$$



continue

$$I_3 = I_{10\Omega} = \frac{\begin{vmatrix} 11 & -3 & 15 \\ -3 & 10 & 0 \\ -8 & -5 & 0 \end{vmatrix}}{\begin{vmatrix} 11 & -3 & -8 \\ -3 & 10 & -5 \\ -8 & -5 & 2 \end{vmatrix}} = \mathbf{1.22 \text{ A}}$$

